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Particle Imaging Velocimetry (PIV) in partially premixed laminar flames: Development of a new post-processing algorithm

by

N. Larass[(a)], A. Boukhalfa[(a)], M. Trinité[(a)], D. Honoré[(b)] and P.F. Miquel[1,(b)]

[(a)]CORIA - UMR 6614 CNRS 76821 Mont-Saint-Aignan Cedex (France)

[(b)]Gaz de France, Direction de la Recherche DEG, BP 33, 93211 La Plaine St Denis Cedex (France)

ABSTRACT

Two-dimensional velocity fields were measured in partially premixed laminar flames using Particle Image Velocimetry (PIV). The velocity measurements were obtained on a multiple slot burner designed with a two-dimensional laminar flow and confined by a combustion chamber with a simplified two-dimensional geometry. These measurements were used to investigate the accuracy of PIV in laminar flames in general, and in partially premixed flames in particular. Focus was placed on measurement accuracy using PIV in the presence of thermophoretic effects and on spatial resolution of PIV image post-processing algorithms.

Images of the flow seeded with refractory particles were obtained for three different flame conditions stabilized on the slot burner using a full-frame CCD camera. The PIV images showed areas of the flow where no particles were detected. The absence of particles in these areas was postulated to be due to the wake of the burner slots and to thermophoresis effects. Thermophoretic velocities were therefore calculated and were found to be on the same order of magnitude than the flow velocity in the vertical direction. Results demonstrate that thermophoresis can induce significant differences between the flow and the particle velocity. Hence caution should be exercised when using PIV in partially premixed laminar flames.

Thermophoresis is also partly responsible for non-homogeneous particle seeding on the PIV images. In areas of the images that were only partially filled with particles, conventional cross-correlation algorithms caused poor spatial resolution due to the assignment of the coordinates of the velocity vector to the center of the correlation window. A specific two-steps post-processing cross-correlation algorithm was therefore developed to increase the accuracy and the spatial resolution of PIV in these areas. This two-steps algorithm was then applied to PIV measurements obtained for the three different partially premixed flame conditions studied here. It was shown that the algorithm did increase the spatial resolution by an order of magnitude.

[1] To whom correspondence should be addressed.